AI in Assisting the Elderly and People with Disabilities

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***Abstract*— The focus of this research is to magnify those technologies that have been developed and that need more modification in their make. We will disclose some machines that have a great impact on the lives elderly and people with disabilities. As we know that artificial intelligence has advanced our life and now we can take advantage of it by using machines though that is related to defense or related to our daily life goods buying robots. These machines are not very common to everybody but we need to do it as these assist more than a human being to elder or disable persons. We also need to invest in these kinds of projects that can be fruitful to human beings. As it is clear that there is no sufficient human resources exist that can assist the elderly and people with disabilities. So ICTs are expected to play its part in assisting those people. In this age, 3D printers making better and better prosthetic for those in need. In the future we will reach a level that will make regular body parts inferior and before we know it the cyborg age will be upon us by this 3D technology. Also in the labs around the world bioengineering have begun to print prototype body parts like ears, noses, artificial bones and skin, even an entire face.**

Keywords—Artificial Intelligence (AI), Intelligent System (IS), People with Disability (PWD), International Classification of Functioning (ICF)

I. INTRODUCTION

We humans have named ourselves the Homo sapiens, which means "man the wise". This is because our mental approach is so important for our everyday life. The area of artificial intelligence is used to understand the artificial entities of our everyday life. Our main focus to study this area is to understand more about ourselves unlike the psychology and philosophy which are more concerned about its impacts, this has helped us a lot. AI has produced such entities even at the early stages of its life that have a very impressive and significant role in our lives. If we take it in recent aspects then AI Systems are being used as robot controls, industrial control, traffic surveillance, and remote sensing. These are a few applications of AI systems, but not limited. The Artificial Intelligence is defined as the study of those system that act, and think rationally and that act, and think like humans [1]. When we talk about systems that act and think like humans they are actually agents. We can define an agent that it is anything which is able to perceive act upon that environment through sensors and effectors respectively. Like a human agents, they have ears, eyes, and other organs that act as sensors and hands, mouth, and legs that act as effectors. Similarly the robots have cameras, infrared range finder, laser range finder, photocell light, and many more as sensors and numerous motor that behave as effectors. Our topic for discussion is to study AI and find the assistive tools that can help in the rehabilitation of disabled persons staying in Artificial Systems study.

According to the World Health Organization disability is any functional impairment which results in loss of function and patient cannot perform it normally or any restriction results from any impairment or an incapacity or absence of capacity to work ordinarily; it might be either physical or mental or both [2]. By knowing the definition we will demonstrate the facts of disabled persons and then we will move to the assistance of these people.

In the recent years, to apply IS in the medical environment is a challenging task in diagnosing, monitoring, and care of patient because of its high risk decisions. But in the rehabilitation of patients, the IS assists as robots that are utilized to control the position of beds to keep from bed ulcers, in the situation of geriatric patients (the persons with overall impaired functions and aged more than 75 years), also in monitoring of bed rails IS are involved [3]. There is a much need for that robots which assist the elderly and people with disability in their independent life. Although numerous assistive robots such as walking assist robots, communication robots, wheelchair robots, and many more have been developed for the cause, but among them a very few are common because of its cost benefit risks ratio. IS are also playing its part in the education of disabled persons too. This is also known as "Special Education" as the special education has broad range of difficulties which results in problems of learning process. But Expert Systems have been developed which aim to behave as human expert in its intellectual tasks.

There are many survey reports have been published regarding the disabled persons and their strength in the society. And also there are many IS have been built for their rehabilitation. We have also purposed some facts about disabled persons in this paper.

II. DISABLED PEOPLE IN PAKISTAN AND ALL OVER THE WORLD

In Pakistan PWDs are 5.035 million, which is more than the total population of New Zealand, Norway, Kuwait or Lebanon. And in this the annual growth is 2.65 percent per year which is also more than the total population growth rate (2.03 percent per year) [4]. This is the reference report of population census 1998, but now the growth rate has increased, and we need first to collect the current data, and for that we need an immediate population census, after that we can take immediate steps for the rehabilitations of disabled people. In Pakistan there is need for making curative and preventive efforts for the well organization of these disabled people at the government and non-government level.

a. Categories of PWDs in Pakistan

In Pakistan most of the PWDs are categorized into the following:

- Hearing Impairment
- Mental Retardation
- Physical Handicap
- Visual Impairment

We will not discuss the origin of these diseases as we are to disclose here the facts and curative techniques through artificial intelligence. But before going to other census we will first discus the WHO, and other agencies report on disabilities.

b. PWDs in all over the World

According to a report by the UN experts on disability stated that 15 percent or more than a billion population of the world is living with disability. And among them 80 percent of the PWDs belongs to developing countries. The same report was also issued by World Bank and WHO. So, we need an immediate forward steps for the rehabilitation of these people.

Now we move ourselves in studying those intelligent systems that have been made for elderly and disabled people.

III. ICF And Automation System for the Rehabilitation of Spinal Cord Injury Patients

Disabilities which happen due to the spinal cord injuries affect both the people physically and mentally and they are unable to participate in daily life activities. Then there is a need to develop such automated systems that can assess and monitor the progress of Spinal Cord Injury patients. As Spinal Cord injury directly affect that part of body, of which veins are affected, and patients get paralyzed. To learn about more on this we have described an automated system using the International Classification of Functioning framework for the health and care of disabled people [5]. But we need to understand the classification of humans and robots.

a. Human and Robots Classification

The behavior of robots and human is a key concept of this study. In this part we have described some key points in the behavioral point of view.

There have been many frameworks for standardization built for robot interactions, and these are:

- Behavioral Markup Language (BML)
- Robot Service Initiative (RSi) Protocol
- Robot Action Commands (RAC) [6]

The BML is a markup language that expresses the multimodal agent's behavior. This provides the utility framework in the designing of multimodal gestures. The RSi is such a communication protocol that is specific for robotic services using the network. Mainly this provides the realization in services at home and offices. The RAC is a set of orders that are the augmentation of Open Robot Interface for Network (ORiN) and works on different platforms of robotic systems like pet and industrial robots. These three frameworks were invented to standardize and generalize the robotic behaviors independent of actual engine or specialist model understanding the conduct. These described methods were robotic activities while many other human interaction methods have also been developed that describe the human activities and mainly being utilizing in healthcare and medical.

- Activities of Daily Living (ADL)
- Metabolic Equivalent of Task (MET)
- International Classification of Functioning (ICF)
- Instrumental Activities of Daily Living (IADL)

ADLs speak to the things we typically do in day by day living including any day by day exercises we perform for self-consideration (for example, sustaining ourselves, showering, prepping, and dressing), work, and relaxation. The limit or powerlessness to perform ADLs can be used as a greatly pragmatic measure of capacity/incapacity in various clutters [7].

MET unit is used to take a gander at the working metabolic rate which is the measure of utilized oxygen by the body amid physical movement to the resting metabolic rate. It is an approach to look at the measure of effort required for various exercises. Very still, the body utilizes one MET for essential capacities, for example, relaxing. Moderate physical movement obliges 3 to 6 METs, and lively physical action need 6 or more METs.

IADL stands for six day by day errands (light housework, get ready meals, taking meds, looking for basic supplies or garments, utilizing the phone, and overseeing cash) that empower the patient to live actively in the society [8].

These techniques defines that how a man can actively and freely live in a society and take part into daily work routines.

Be that as it may, they are fairly harsh in discovering the point by point needs of a man. ICF is another method for depicting the exercises of a person with better and more extensive portrayal capacity, but in the next section we'll explain the ICF and its role in the rehabilitation process.

b. ICF based Automated Systems

International Classification of Functioning, Health and Disability is a WHO approved classification of health and relating to health components aiming to provide the standard and unified framework to describe the health and related areas.

ICF has been classified into two subclasses:

- Functioning and Disability
  - Activities and participation
  - Body functions and structures
- Contextual Factors
  - Personal factors
  - Environmental factors

Each of described class has various domains and components, but we'll not go to further explanation of this as we are to describe an ICF model for the assistance of disabled people.

i. Human Life Model using ICF

There is a holistic model for the human life which has been provided by the ICF is shown in the Figure 1 that has various interactive components.

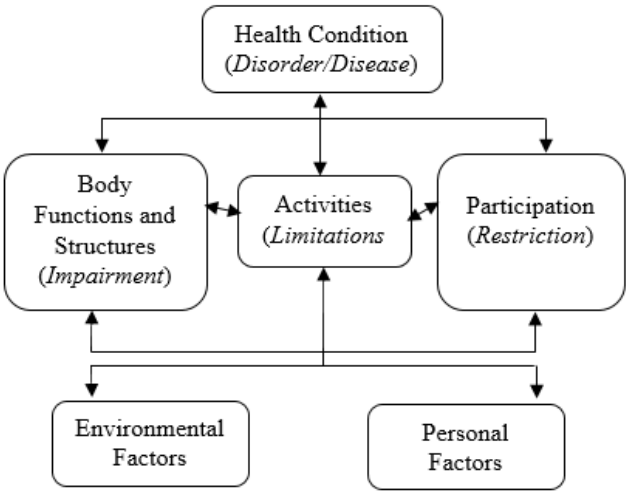

Figure 1: ICF Model

Body functions include the mental functions, sensory functions, voice and speech functions, cardiovascular and hematological, immunological and respiratory systems, and also movement related functions exist within the body functions. Body structures include eye, ear and related structures and all the structures of above said functions. Activities and participations include the major life area in which learning and applying, mobility, communication, interpersonal interactions and community life exist. And last one the environmental factors include the technology and products, human made changes to environment, and attitudes, services and policies make for environment.

Basically ICF relies on the integration of social and medical model. The assistive robots are related to "Environmental Factors" as this include the products and technology.

The core feature of purposed discussion are:

- Thorough arrangement to portray human life
- Standardized (framework) language which is sharable among individuals included
- Holistic view (model) about human life

The described study is about the ICF based human life models now we proceed our study to evaluate the development of assistance robots.

c. Assistive Robots Development Using ICF

In the evolution of assistive technology, the assistive robots also evaluated. But assistive robots were made as an application of preexisting technologies, and they brought to take benefit in human life. The assistive robot designer should keep in mind the following life design in order to build such robots.

- Functional training
- Assistance from family
- House renovation
- Assistance from helpers
- Assistive robots
- Assistive devices

In the development phase many aspects are to be look after, like design of the robots should be adaptive by users, its analysis on daily life, and its evaluation qualitatively and quantitatively and also checking the user requirements. These all phases are involved in the development process of assistive robots [8].

These assistive technologies have been very rare for those people who cannot afford these physical assistive robots. Such as, the people who are suffered with spinal cord injury, their limbs and arms may be affected by this, and they become unable to perform daily life tasks. This is very common in developing countries like Pakistan, but to overcome this issue and to overcome financial issue governmental and non-governmental roles are very important in this respect. Now we'll move our study to disclose these artificially intelligent devices that have a remarkable role in society.

d. Assistive Systems for Rehabilitation of Spinal Cord Injury Patients

There have been many trends introduced in the assistive technology for the rehabilitation of spinal cord injury patients. Some of these mobility systems are

- Power wheelchair
- Computer vision enhanced control system
- Prosthetic limbs
- Peripheral nervous system control (PNS)
- Functional electrical simulation
- Kinematic or kinetic control systems
- Robotic exoskeletons

We need integration of these technologies in the same way as the capabilities of assistive technologies and user need meet the criteria. The criterion for this is following:

- Improved mechanics of assistive technology
- Improved physical interface of user technology
- Improved shared control [9]

The improved mechanics include improvement in software and hardware, and improved physical interface of user technology include the better utilizing the abilities of client to work the innovation and giving more natural gadget control. The ICF based systems for the rehabilitation purpose are explained below.

i. Power Wheelchair

Power wheelchairs are usually joystick operated machines and also have some other switches to change functions. These capacities incorporate the wheelchair movement, footrest elevation, backrest recline, seat tilt, and seat elevation. It has increased mobility of neuromuscular capacity to navigate dynamically with a joystick. In the consequences of "shared control improvement" it is that kind of technology which assists the user in path navigation system [10]. Typically it has various methods that vary in movement algorithms and assistance provided in the perspectives of user autonomy.

There are many other approaches have been introduced for power mobility such as tongue based control interface which has the capability to control the chair, and it is the better interface design for those patients who has lost the capability of operating through any other part of body.

Dr. Etienne Burdet's who are the Human Robotics specialist at the Imperial College, in a joint exertion with the NUS (National University of Singapore), has developed an ease power wheelchair shared control system considering way heading that gives a third way to deal with shared control. It is a CWA (collaborative wheelchair assistant) that is the "individuals who think that its troublesome or difficult to utilize a standard force wheelchair yet have adequate tactile capacities to identify when halting is vital, for example the persons with paralysis of cerebral parts, locked-in individuals, or traumatic cerebrum harm patients [11].

There are many other approaches in this collaboration have been made that is the Sensory Motor Interaction (SMI), the SMI is such a system that relies on intraoral device and ferromagnetic piercing with 18 sensors. Another approach in this regard is Brain Computer Interaction (BCI), the BCI first detects, then decodes, and last communicates from brain electrical programs. The computer using the pre-programmed paths then derives the wheelchair between the destinations [9].

ii. *Computer Vision Enhanced Control System:* A camera based shared control framework have been created by an examination bunch at the University of Alborg that automatically chooses the best possible hand utilizing the picture acknowledgment to handle shape, and size in light of the pictures being controlled utilizing the picture acknowledgment. In this scenario the user is responsible for a few operation which are to make decision, to trigger, and to position the hand. On the other hand camera based control in this way chooses and executes the grip sort and handle size. This framework has been tried over more than 15 non-disabled people that have utilized it for the controlling actions of an artificial hand.

iii. *Prosthetic Limbs:* Prosthetic improvement challenges incorporate supplanting both the afferent and efferent sensory systems which include tangible input and development as well respectively [12]. Satisfactory prosthetic appendage control will be accomplished when both efferent and afferent frameworks are enough supplanted.

iv. *Peripheral Nervous System Interface Control:* It consists of motor neurons and sensory neurons, and PNS also subdivided into two categories that are autonomic nervous system and sensory-somatic nervous system. Furthest point prosthetic control is trying because of both the quantity of conceivable movements which can be controlled and also the predetermined quantity of locales for conventional control interfaces. In this respect, the best choice is use the same nerve that is used to send afferent and efferent data between

mind and arm. Conceivably, this is more natural methodology that is used to convey the more tangible input to the user [13].

v. *Functional Electrical Simulation:* It remains an innovation with awesome potential for reestablishing development. Its utilization is constrained to a limited extent when and exertion required to wear the frameworks.an Actigait has been created at the University of Alborg, which is used in the help of expanding on sleeve cathode innovation. A case has been studied for implanting such a service that is Neurostep and it additionally times muscle incitement in light of detecting afferent action in fringe nerves.

vi. *Robotic Exoskeletons:* The research on robotic exoskeletons was initiated in 1960's by the military. There have been a mobility for the people with disability introduced and become a focused research topic. The robotic exoskeletons must meet the following characteristics, which are:

- Human and Robot multimodal cognitive interaction
- Truly Wearable and portable
- Physical interaction of safe and dependable
- Usability and acceptance of user centered aspects

These aspects must meet in the rehabilitation and assistive technological factors. As described in the said factors the user can anytime adopt or leave the assistive technology.

So, the described technologies are those which are being used for the rehabilitation process of PWDs and have a great impact in it.

IV. Artificial Intelligence for Disabled and Elderly People

As society builds up, the change of the nature of life is turning into a crucial assignment. As the therapeutic consideration framework enhances the personal satisfaction, the number of inhabitants in elderly individuals is developing. Then again, the populace that backings elderly persons is diminishing. This implies elderly individuals are turning out to be forlorn in cutting edge society. The circumstance of physically handicapped individuals is like that of elderly individuals. Robotic technology innovation is growing drastically. In this sense, the robot framework is an option since precision for sensors and control framework is expanding and PC innovation, one of essentials in apply autonomy, is quickly creating.

Thus a nursing robot also playing an important role for the rehabilitation of PWDs. In the next section, we have described the working scenario of a nursing robot.

a. Nursing Robot for the Elderly and PWDs

The main purpose of assistive robots is to provide assistance to the elderly and people with disability. So, to perform the actions for assistance the mechanical parts of the robot also play core role. These robots made so that impaired people can move and perform actions independently. A nursing robot system has been developed that has many features for the assistance of people with disabilities, and supporting roles for the elderly people to perform their daily life tasks.

The main role of a robot is to provide portable help to those people who experiences issues in the movement of an indoor situation and assists in different stimulation services, for example, playing music, film, and so on. For help purposes, the robot is consists of an arm supporter which helps in supporting the abdominal area of user. The robot is controlled by the user by installed switches ion it. There are two wheels also installed in robot so that it can move by itself to a location or it can also be controlled by the user. There are also infrared and ultrasonic sensors are installed in the robot that are used to find the hindrances in the way of robot and also helps to maintain its position from that hindrances regardless of the errors of operation by the user.

There are also few cameras and the microphones are installed in the robot that helps the robot to perceive situations. The robot head has two installed color cameras which helps the robot in tracking and detecting the human and face respectively, so that it can reach the target within time and provide the assistance. The two microphones assists in getting and restricting the sound resource. On the other hand if one wants a service from robot, he can advise by applauding to robot. The robot then get, recognizes, and confines the source of sound by using its microphones [15]. For entertainment purposes, the user essentially touches the menu in the LCD screen.

b. Google's Driverless Car

This car is much more beneficial for the visually impaired people, and also beneficial for any kind of impaired people with any kind of disability whether they are handicapped or individuals with metal disorder. This car works with google map and artificial intelligence surrounding data collected by many sensors and cameras manipulated over the car.

c. Kapten Plus Personal Navigation System

It is a GPS implanted traveler device for the visually impaired people. It speaks the direction to the user and people don't disoriented by this device also it comes in cheap price and best for developing county PWDs.

d. DynaWox EyeMax System

It consists of VMax and DynaVox EyeMax systems that give the ability to participate in spoken communication to the paralyzed, stroke, and cerebral palsy victims. Using the implanted eye tracking system the users are able to communicate with their eyes and then writing words with a sophisticated keyboard on the screen by allowing it to write words for you, and then translates the words into spoken communication via the device text to speech mechanism.

e. Home Automation

The home automation is also known as assistive domotics that concentrates on making it feasible for elderly and PWDs to stay at home, protected and comfortable. Home automation is turning into a practical choice for elderly and PWDs who might want to stay in the solace of their homes instead of move to a healthcare office. This field utilizes a great part of the same innovation and hardware as home computerization for security, stimulation, and vitality protection yet tailors it towards more established elderly and PWDs.

The home automation have implemented systems that can be from simple alerts to computer automated controlled networks. This system includes the monitoring devices such as motion sensors, video cameras, environmental controls, emergency, and alert assistance systems.

The home automation also include the following systems:

- Retrofit automatic door opening systems
- Wireless socket control systems
- Powered cupboards
- Entry control systems
- Automatic curtains and blinds
- Lighting controls

Except the said systems many other medical robots for the elderly and PWDs have been developed such as medical dispensing robots, Spoon feeding, and care providing robots. Medical dispensing ensures that all the necessary medicines have been taken at the appropriate time, automated pill

dispensers ensure that appropriate pills have been dispensed and other pill for the specific time are locked to be taker at the later time. The care providing robot was developed by the Institute of Automation which belongs to University of Bremen, and it is a semi-autonomous robot and its role is to provide to provide assistance to the elderly and PWDs like preparing meals, serving it and reintegration of it in professional life.

V. CONCLUSION

In this paper we have described a number of approaches, we described the census for PWDs and survey reports. We also disclosed the summary of ICF based systems for the patients of spinal cord injury patients, as this harms the people and people becomes unable to perform daily life tasks. Also the PWDs are those people who are the deactivated part of our society, healthy persons don't give them much intention and to overcome their disability ICTs need play their role in assisting them with technology. As this is the era of artificial intelligence though it is challenging in many respects but we can overcome this issue. We described a number of assistive robots such as powered wheelchairs, prosthetic limb controls, peripheral nervous systems, home automation systems, functional electrical simulations, and exoskeleton robots etc. These are the technologies which need to be cheaper so that it can be used by any PWD and this is what we need to do.

In the engineering of ICF based systems the technology has just begun, there may be errors and hurdles but soon this will be the adaptive technology and advancement in this field is truly useful for the assistive robots. Artificial Intelligence strategies have effectively been connected to take care of issues in the field of a special education. There is a general accord amongst researchers that counterfeit consciousness techniques can coordinate the opportunity of activity of the client user, and lead him or her toward faculty learning objectives.

There is also need of modification in these technologies and we need to implement more efficient algorithms for the advancement of such robots. We are now at a point where the AI is advanced enough that it can make the significant differences in the lives of elderly and people with disabilities.

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